

[54] **METHOD OF PREVENTING VAPOR LOCK DURING ENGINE OPERATION AND OF FUEL LEAKAGE TO CARBURETOR AFTER ENGINE STOPPAGE**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 726,308, May 3, 1968, Pat. No. 3,559,680, which is a continuation-in-part of Ser. No. 616,594, Feb. 16, 1967, abandoned.
[52] U.S. Cl. 137/12, 137/563, 137/569, 417/311, 261/72
[51] Int. Cl. F04b 23/00
[58] Field of Search 137/12, 563, 569; 417/311; 261/72; 123/139

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[57] **ABSTRACT**

Vapor lock which might otherwise occur in its fuel supply pump during high temperature operation of a liquid-fuel engine, is minimized or eliminated by continuously withdrawing a small fraction of the flow liquid from the bottom level of the pump outlet conduit and reintroducing it at the top level of the pump inlet conduit. Also, after pump and engine stoppage, pressurized liquid remaining in the pump to carburetor (outlet) conduit, is prevented from dribbling into the carburetor and vaporizing into adjacent space (and creating a fire hazard and air pollution) by relieving the back-pressure in such conduit and then closing same without breaking the liquid column, by valve means in the (sigmoid) pump bypass. Such small capacity bypass may be left open during pump and engine function, without interfering with normal operation, and closes in response to decreased back-pressure in the line when the pump stops.

5 Claims, 2 Drawing Figures

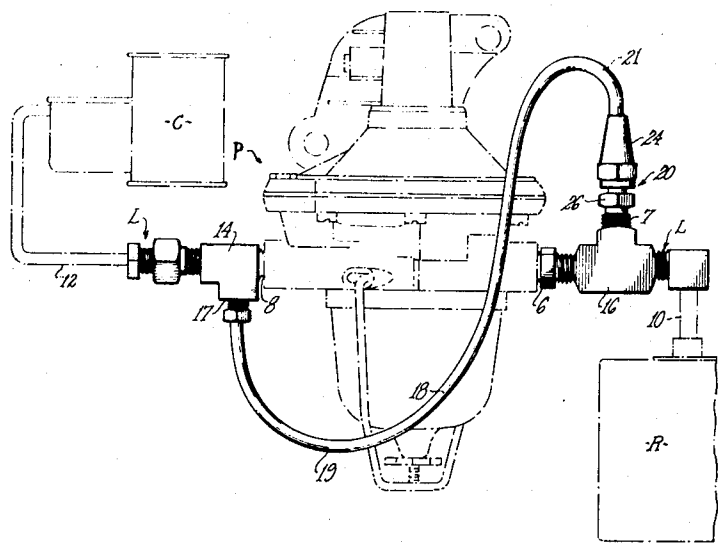


FIG. 1.

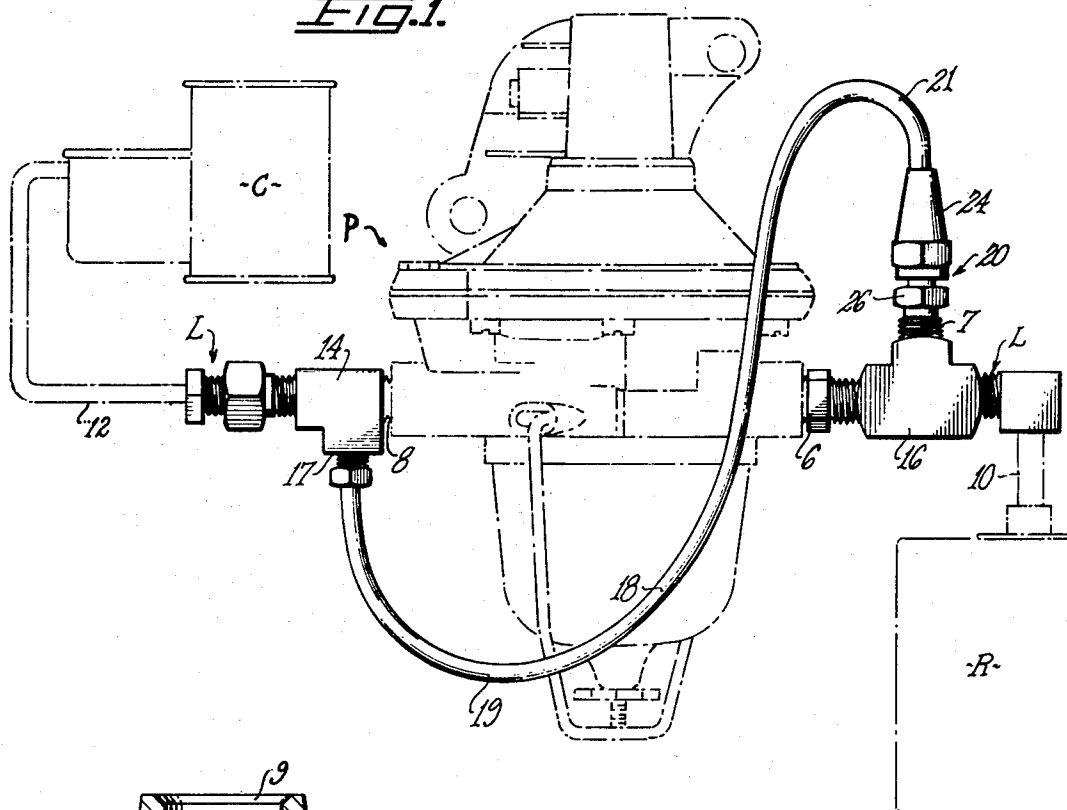
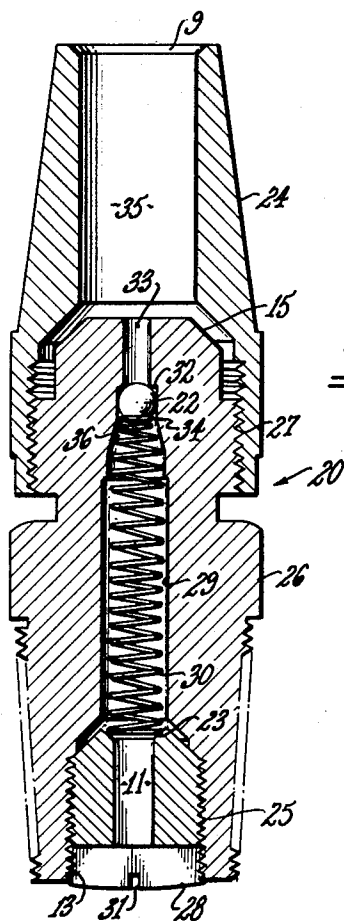


FIG. 2.



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METHOD OF PREVENTING VAPOR LOCK DURING ENGINE OPERATION AND OF FUEL LEAKAGE TO CARBURETOR AFTER ENGINE STOPPAGE

This is a continuation-in-part of Ser. No. 726,308, filed May 3, 1968, now U.S. Pat. No. 3,559,680, which is a continuation-in-part of Ser. No. 616,594, filed Feb. 16, 1967, now abandoned.

BACKGROUND OF THE INVENTION

Motorists driving in elevated temperatures, such as the summer-time desert, as well as in rarefied atmospheres such as high mountain areas, have become familiar with the problem of "vapor lock." This is caused by volatilization of liquid fuel in the pump and in its delivery line to the carburetor. Partial vaporization cuts down the quantity of liquid fuel being pumped to the carburetor, in part because of a gas pocket being retained in the pump or outlet, so that the gas reduces the area left for liquid passage. The engine chokes or sputters. At this point, the motorist may stop the car and throw water on the fuel pump in an effort to condense the trapped vapor, or to try to get the pump to purge it from the system. However if such effort is unsuccessful (or is not resorted to), further volatilization of the fuel may substantially completely fill the pump with vapor so that no liquid fuel at all is passed to the carburetor and the pump is "locked"; obviously the motor then stalls and the vehicle stops. When the vaporization has proceeded to this extent, it may not be reversible simply by cooling the pump since the liquid flow or column has been broken. The pump has to be primed with liquid in order to restore its function.

Aside from cooling the engine, this problem has been dealt with by providing gasoline blends or the like, having a higher boiling point; such blends are then less effective at lower temperatures. Obviously a simpler solution of the problem would be desirable.

Still another irritating problem of long standing has been that resulting from the column of pressurized fuel remaining in the pump-to-carburetor conduit when the pump and engine are stopped. Especially in the presence of a leaky needle valve in the carburetor, this liquid dribbles into the carburetor and evaporates into the surrounding space. Especially in a closed space such as the engine compartment of a small boat, this concentration of combustible gases is highly explosive upon introduction of a spark, such as that provided by engine start-up. Many fires which completely destroyed the marine craft or motor boat have had such origin. Such accumulated (gasoline) vapor is also toxic to persons (or animals) having to inhale it. Beyond that, it is a general pollutant of the atmosphere, which when multiplied by the large number of "wet carburetors" on both land vehicles as well as marine craft, dumps a tremendous tonnage of contaminants into the air over any area which contains an active concentration of internal combustion engines. In brief, such undesirable venting of unburned fuel vapor results both from conditions associated with vapor lock and from carburetor needle valve leakage. Both conditions benefit from the present invention.

BRIEF SUMMARY OF THE INVENTION

As noted in the preceding abstract, leakage from the pump to carburetor after engine shut-down is prevented by relieving the pressure of the trapped liquid-fuel in the pump outlet conduit, while retaining the column of liquid unbroken in this line so that it neither dribbles into the carburetor or drains back toward the fuel reservoir (as it would if the latter were at a lower level). Vapor lock of the fuel pump during operation, is prevented by bleeding of a small line of liquid from the lower level of the pump outlet conduit and returning it to the upper level of the pump inlet line. Such a circulation (bypass) is in continuous operation during operation of the pump, typically by use of an S-shaped or sigmoid bypass conduit of small internal cross section relative to the cross section of the pump inlet and outlet conduits. Such bypass can additionally be used to relieve the pressure of the fuel trapped in the outlet conduit

after engine and pump shut-down, by provision in the bypass conduit of a normally-open valve which closes (after pump stoppage) in response to decrease of back-pressure in the outlet line. Thus a single and simply-installed unit or assembly will perform both functions or method-steps in sequence, and solely in response to movement of liquid-fuel through the pump outlet conduit.

In this connection it may not be completely understood why the method of relieving vapor lock depends upon withdrawing the bypass stream from the lower outlet level and reintroducing it to the upper (pump) inlet level. However, (vertical) bypass loops from top to top, as well as from bottom to bottom are singularly unsuccessful; so are bypass lines disposed at the same horizontal level; so is an S-loop from top of outlet to bottom of inlet. It may be that withdrawal from the bottom outlet level permits bubbles to be swept to the carburetor rather than into the bypass and by such "fractionation" relieves vapor which has started to form in the pump and thus prevents its accumulation in situ. In any event, the two problems (vapor lock and wet carburetor) which were not previously thought to be associated, are thus solved simultaneously or at least in sequence by these two method steps.

The present method which both counteracts threatened or potential vapor lock during engine operation, and prevents leakage of liquid-fuel from the pump to the carburetor (and its subsequent vaporization into the atmosphere as from a flooded carburetor) after pump stoppage, may be effected by use of a simple pump bypass assembly such as herein illustrated, which unit can be readily installed on conventional internal combustion engines whether stationary engines or those used to propel land vehicles or marine craft (as well as airplanes).

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of my bypass assembly connected to an automotive fuel pump (shown in broken lines), with the fuel reservoir and carburetor indicated schematically; and

FIG. 2 is an axial sectional view of the bypass valve unit alone, seen in upright, operative position.

DESCRIPTION OF A PREFERRED EMBODIMENT

As here illustrated, a conventional liquid-fuel pump P is located intermediate the length of the fuel line L which extends from a fuel reservoir R (i.e., gasoline tank) to the carburetor C of an internal combustion engine (not shown) which utilizes the carburetor-atomized fuel in the usual manner. The portion of the fuel line extending from the reservoir to the pump may be designated as the inlet conduit 10, and the portion from the pump to the carburetor as the outlet conduit 12. It will be understood that an unbroken stream or column is maintained in the line, whether moving or not. The liquid in the reservoir R is ordinarily under ambient atmospheric pressure, while the fuel in the outlet conduit 12 is under the pressure added by the pump P, which is usually on the order of about 1 to 10 p.s.i.g. with diaphragm-type pumps.

Essentially the present assembly consists of a pair of T-fittings 14, 16, a (S-shaped) bypass conduit 18 and a valve assembly 20. One Tee, 16, is connected between the inlet conduit 10 and the inlet port 6 of pump P, with its upstanding nipple 7 coupled to the valve assembly 20 above it. The other Tee, 14, is inserted between the outlet conduit 12 and the output port 8 of the pump P with its downturned nipple 17 joined to the downwardly concave segment 19 of the bypass conduit 18. The successive convex segment 21 of the bypass conduit is received in the aperture mount 9 of the upper housing piece 24 of the valve assembly 20. Preferably the internal diameter of bypass conduit 8 is about 1/6 or less that of the outlet conduit 12.

The valve assembly proper 20 is formed of a longitudinally apertured, two-piece housing shell or tube 24, 26 threadedly coupled together at the insertion neck 27 of the lower piece

26. A metering plug 28 is formed with an axial bore 11 which defines the flow capacity of the bypass 18, being threadedly mounted at 25 in a tapped end-socket 12 of the lower housing 26. A slotted end 31 enables axial adjustment of the plug 28, which at its inner end 23 forms a seat for the lower end of a compression spring 30 which is loosely disposed within the housing chamber 29. At the upper end of the housing 26, it is peripherally relieved at 15 and axially drilled partway to form a restricted bore 33. At the inner end of the bore 33 an out-stepped annular shoulder 32 forms a seat for a check ball 22, the underface of which is supported by the terminal coil 34 of the spring 30. Below the stepped area, the channel tapers outwardly at 36; into which tapered or conic section the valve 22 partially projects even when seated, and into which it is progressively thrust by increased back pressure from the passage 35. It will be seen that the ball is in a position of gravitational descent, supported only by the weak spring 30, so that a comparatively small back pressure (e.g. $\frac{1}{2}$ p.s.i.g. or less) in the line 18-35-33 will serve to open it. However, when such minimum back pressure fails, it is immediately closed by the tension of spring 30 (which tension can be set or adjusted by positioning the plug 28).

Thus it will be seen that the added assembly has a dual function: When the pump P is operating, the return flow of liquid through the open bypass 18, which is actually metered to a small trickle by the small diameter of the passage 33, does not appreciably curtail the main fuel flow through the supply line L; but the bottom-level pickup provided by the descendingly bowed segment 19 of the bypass has been found to be particularly effective (from comparison with a top-side pickup from the same outlet conduit location by an over-the-top-of-pump C-shape conduit) to minimize or eliminate vapor lock in the operating pump. Secondly, the valve 22 which is lightly loaded by the spring 29 so as to open at a low back pressure in the bypass 18, although continually open during normal pump operation, is successively functional after cessation of pump action has stopped the main fluid flow through the supply line 12-10. At such time, the still-open valve first equalizes the line pressure of the carburetor side 12 against the unpressurized feed line 10, and then automatically closes so as to still retain liquid in the whole line (even in the event of a leaking carburetor needle valve). On the other hand, if for any reason the pressure on the reservoir side of the pump should exceed that on the opposite side after the pump has stopped, the valve 22 would close at once so as not to exert this additional pressure against the carburetor needle valve. It is notable that this overall or composite result is obtainable without any alteration of an existing or installed pump, and merely by incorporation — because of the Tees 14, 16 at connections already present on the fuel pump — of the present simplified and highly effective, self-operating structure.

It will be clear to those skilled in the art that changes of construction and operation may be made within the present in-

ventive concept, and therefore this disclosure is not to be limited to the precise details shown in the drawings and particularly described in the specification by way of example, but it is my intention to claim the invention broadly as hereafter defined.

What is claimed is:

1. In a method of moving a liquid-fuel supply from a liquid-fuel reservoir by a pump inlet stream and pumping the fuel to a carburetor of an engine by a pump outlet stream so as to move liquid fuel to the carburetor from the reservoir at a normal operating pressure of the pump, the steps for restraining fuel entrance to the carburetor from the pump outlet stream after pump stoppage, comprising:

back-relieving substantially all pressure in the outlet stream by reverse movement of a small stream of the liquid fuel having a very small cross-sectional flow area in respect to an internal cross section of the outlet stream so as to bypass the pump after cessation of pump operation until the pressure in said outlet stream is substantially equalized with the pressure in said inlet stream, and then stopping said reverse movement in response to decline of backpressure in said outlet stream so as to retain unpressurized liquid which was in the outlet stream from draining into the carburetor after the pump has stopped.

2. The method of the preceding claim 1 wherein continuously during pump operation said small stream is enabled to move to a top level of the inlet stream from a bottom level of the outlet stream, thereby minimizing occurrence of vapor lock in said pump.

3. In a method of moving a liquid-fuel supply from a liquid-fuel reservoir by a pump inlet stream and pumping the fuel to a carburetor of an engine by a pump outlet stream so as to move liquid fuel to the carburetor from the reservoir at a normal operating pressure of the pump, the improved step comprising:

relieving potential or actual fuel vaporization in the pump or outlet stream by continually passing a small stream of the liquid fuel from a bottom level of the outlet stream to a top level of the inlet stream thereby reverse bypassing the pump and enabling purging of vapor formed therein so as to maintain a continuous supply of liquid fuel to the carburetor and prevent severance of such supply by occurrence of vapor lock in the pump.

4. The method of the preceding claim 3 wherein said small stream of bypassing liquid fuel enters the pump inlet stream by a downwardly concave segment of a sigmoid path arising from the bottom level of the outlet stream.

5. The method of the preceding claim 3 wherein upon pump stoppage, flow of said small stream of bypassing liquid fuel is stopped in response to decline of backpressure of the pump outlet stream, thereby preventing pump-pressurized liquid which was in the outlet stream from draining into the carburetor after the pump has stopped.

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